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Acquire the first X-ray at a known angle, measure IMD, measure medial plateau width, calculate depth = 1.78*width, calculate IMD angle as sin α = IMD/depth. The correct LS angle is the sum of α and the existing X-ray angle. However, because it is impossible to tell from the X-ray if the posterior or anterior tibial rim is higher there is uncertainty whether to increase or decrease the beam by α. As a result there is a 50% chance of moving in the wrong direction and requiring a third X-ray.
To test this technique the baseline x-rays of 70 subjects from the A9001140 study were used. Each subject had a fixed flexion (FF) x-ray acquired at 10° and a successful LS x-ray, defined as an IMD < 1.5mm acquired through iteration. The optimizing technique was applied using the FF x-ray as the starting point and the result compared to the "optimal" beam angle used to acquire the LS x-ray.
Results: The observed LS angles ranged from 1 to 17 degrees with a median value of 9. The predicted LS angles ranged from 3 to 16 degrees with a median value of 9. The angles predicted by this method were within 1 degree of the LS angle determined by iterative x-ray acquisitions in 83% of the cases. For 7% of the cases the predicted angle was between and 1 and 2 degrees of the observed LS angle. For KL scores of 0, 2, and 3 the predicted LS angle was within 2 degrees of the observed angle 97%, 83%, and 84%, respectively. In cases where there was a difference between the prediction and the acquired LS x-ray it was not possible, in this retrospective study, to determine if the predicted beam angle would have also yielded an acceptable LS x-ray. Additional studies are required to verify the appropriate ratio for different subject populations such as male subjects.
Conclusions: Using this technique the optimal LS x-ray angle could be objectively determined permitting a successful acquisition with 2 or 3 X-rays reducing the overall radiation exposure over previous methods which often required 4 or more x-rays or fluoroscopy. This also permits the x-ray technologists to reliably acquire a LS x-ray with a more systematic approach that doesn't require intuition or experience.

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RISK FACTORS FOR PREVALENT TIBIO-FEMORAL CARTILAGE DAMAGE IN SUBJECTS WITH FREQUENT KNEE PAIN: THE JOG STUDY

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Purpose: Cartilage damage is one of the hallmark features of osteoarthritis and may be assessed indirectly by radiography or directly by MRI. Cross-sectionally, cartilage damage is associated with subchondral bone marrow lesions (BMLs), bone attrition, meniscal damage, malalignment and ligament pathology. Certain demographic factors in addition seem to increase the risk of cartilage damage in the knee joint. Purpose was to analyze the cross-sectional associations of several demographic and MRI-based risk factors with prevalent cartilage damage semiquantitatively assessed at 3 T MRI.
Methods: The JOG study includes 177 subjects aged 35-65 with chronic, frequent knee pain. 3 T MRI of both knees was performed at baseline on a Siemens Trio system using the same pulse sequence protocol as in the Osteoarthritis Initiative (OAI): sagittal IW 2D TSE FS, sagittal 3D DESS WE, axial MPR of SAG 3D DESS WE, coronal MPR of SAG 3D DESS WE. MRIs were assessed by one expert MSK radiologist according to the WORMS scoring system. Cartilage status was scored on a scale from 0-6 using all 5 sequences in each of 5 subregions (i.e., anterior, central and posterior subregions in the tibia and central and posterior subregions in the femur) in both the medial and lateral compartments for a total of 10 subregions. Meniscal status, meniscal extrusion, and the presence of synovitis/effusion was included in the analysis. All MR features were divided into two categories: present (score ≥1) and absent (score=0). We performed a subregion-based analysis using GEE to account for the clustering of subregions within a knee and knees within an individual. Multivariate models were adjusted for age, gender and BMI. All MRI risk factors were adjusted for each other in the multi-adjusted model.
Results: 51.2% of participants were men, mean BMI was 29.1 (± 4.1). Baseline Kellgren/Lawrence grades were (worst K/L grade for either left or right knee): K/L 0: 37 (20.9%) knees, K/L 1: 14 (7.9%) knees, K/L 2: 26 (14.7%) knees, K/L 3: 81 (45.8%) knees K/L 4: 19 (10.7%). Of the 353 knees, 304 knees (88.6%) and 1,153 subregions (28.0%) exhibited cartilage damage. Of the subregions showing cartilage damage focal damage (WORMS 2.0 or 2.5) was observed in 243 subregions (21.0%). BMLs were present in 12.3% of subregions. Comparing subregions with vs without BMLs, 82.8% vs 15.5% exhibited cartilage damage, respectively.
Significant predictors of the presence of cartilage damage in this cross-sectional analysis were age, presence of synovitis or effusion, prevalent meniscal damage, meniscal extrusion and BMLs (Table 1).

Table 1. Cross-sectional associations of demographic and MRI-based risk factors with prevalent cartilage damage

Risk factor	Reference	Odds Ratio[4] (95% confidence intervals)
Age -mid tertile[1]	Youngest tertile	1.88 (1.27-2.79)*
Age -oldest tertile[1]	Youngest tertile	2.60 (1.73-3.92)*
Gender - female[1]	Male	0.92 (0.68-1.26)
BMI – overweight (25-30)[1]	BMI < 25	1.36 (0.87-2.15)
BMI – obese (> 30)[1]	BMI < 25	1.48 (0.95-2.30)
Synovitis and effusion[1]	All synovitis /effusion scores = 0	1.83 (1.28-2.63)*
Meniscal damage[2]	No meniscal damage (WORMS=0)	3.63 (2.50-5.25)*
Meniscal extrusion[2]	No meniscal extrusion	1.71 (1.24-2.37)*
BML[3]	No BML in subregion	16.59 (11.66-23.60)*

[1]cartilage damage in any of 12 subregions
[2]cartilage damage in same compartment as meniscal damage or extrusion (6 subregions medial or lateral)
[3]cartilage damage in same subregion as BML
[4]multi-adjusted GEE model accounting for correlations within and between knees
* statistically significant at p ≤ 0.05

Conclusions: Confirming previous work several MRI detected tissue pathologies are strongly associated with cartilage damage in adjacent subregions. The strongest cross-sectional predictors of cartilage damage were subchondral BMLs followed by meniscal pathology. Of the demographic factors only age showed an association with cartilage damage. The course of events leading to chondral pathology needs to be determined in longitudinal studies with multiple time-points.

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36 MONTH FOLLOW-UP OF 3T MRI KNEE CARTILAGE T2 MEASUREMENTS IN INDIVIDUALS FROM THE OAI INCIDENCE AND CONTROL COHORT

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Purpose: To compare knee cartilage T2 relaxation time values in individuals from the Osteoarthritis Initiative incidence cohort with risk factors for knee osteoarthritis versus normal controls at baseline and after 36 months
Methods: Forty-nine individuals (19 male, 30 female) with risk factors for knee osteoarthritis were randomly selected from the incidence cohort. Inclusion criteria were 45-55 years of age, BMI of 19-27 kg/m^2, no knee pain in either knee (WOMAC score of zero) and a *Kellgren-Lawrence (KL)-Score* equal or greater than one in right knee radiographs at baseline. In addition, using the same age, BMI and WOMAC criteria, 51 individuals (17 male, 34 female) from the control cohort with no risk factors for knee osteoarthritis and a *KL-Score of zero in right knee radiographs* at baseline were included. Baseline and 36 month follow-up 3T MR images of the right knee were obtained. Cartilage segmentation and T2 relaxation time measurements were performed in five compartments (patella, medial/lateral femur and tibia). General linear models were used to adjust for age, gender and BMI and to compare means and changes of T2 values of the two groups.
Results: The incidence group showed higher mean T2 values in all compartments at baseline and after 36 months. Differences reached significance in the medial femur compartment at baseline and 36 month follow-up ($p<0.001$, respectively $p=0.031$). The mean T2 value in the medial femur compartment amounted 52.43ms in the incidence group (versus 49.88ms in the control group) at baseline and 55.37ms (versus 53.61ms) after 36 months. T2 values of all compartments increased over 36 months in both groups (p-values < 0.001). The increases of the T2 values were comparable between the incidence and control group in all compartments and differences were non significant ($p>0.05$). The highest increases were found in the medial tibia compartment (7.48ms in the incidence group versus 7.78ms in the control group) and medial femur compartment (2.85ms versus 3.73ms)